Surgical management of popliteal artery aneurysms: Which factors affect outcomes?

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Objective: **Popliteal artery aneurysm (PAA) is uncommon. The clinical presentation of PAA includes rupture, embolism, and thrombosis. In this article, we evaluate the results of our 20-year experience with surgical management of PAAs, analyzing the role of anatomic, clinical, and surgical factors that potentially affect early and long-term results.**
Methods: **From January 1984 to December 2004, 159 PAAs in 137 patients were operated on at our department. Data from all the patients were retrospectively collected in a database. PAAs were asymptomatic in 67 cases (42%); 5 (3%) PAAs were ruptured. In 51 cases (32%), PAA caused intermittent claudication. The remaining 36 limbs (23%) had threatening ischemia due in 30 cases to acute PAA thrombosis, in 4 cases to chronic PAA thrombosis, and in 2 cases to distal embolization. In selected patients with acute ischemia, preoperative intra-arterial thrombolysis with urokinase was performed. Early results in terms of mortality, graft thrombosis, and limb salvage were assessed. Follow-up consisted of clinical and ultrasonographic examinations at 1, 6, and 12 months and yearly thereafter. Long-term survival, patency, and limb salvage rates were analyzed.**
Results: **Forty cases were treated with aneurysmectomy and prosthetic graft interposition; in 39 cases, the aneurysm was opened, and a graft was placed inside the aneurysm. Four patients had aneurysmectomy with end-to-end anastomosis. In 73 cases, ligation of the aneurysm with bypass grafting (39 with a prosthetic graft and 34 with an autologous vein) was performed. The remaining three patients underwent endovascular exclusion of their PAAs. A medial approach was used in 97 patients (61%), and a posterior approach was used in 59 patients (37.1%). The outflow vessel was in most cases (93.7%) the below-knee popliteal artery. Thirty-day amputation and death rates were 4.4% (7/159 limbs) and 2.1% (3/137 patients), respectively. The amputation rate was significantly higher in symptomatic limbs than in asymptomatic ones (6.5% and 1.4%, respectively; $P = .05$). Eight limbs (5%) had an early graft thrombosis that required a reintervention. Follow-up was available in 116 patients (84.7%) and 138 limbs (86%) with a mean follow-up time of 40 months (range, 1-205 months). The cumulative estimated 60-month survival, limb salvage, and primary and secondary patency rates were 84.2%, 86.7%, 66.3%, and 83.6%, respectively. Asymptomatic limbs had significantly better results than symptomatic ones in terms of limb salvage (93.4% and 80.4%, respectively; $P = .03$; log-rank, 4.2) and primary patency (86.5% and 51.6%, respectively; $P = .001$; log-rank, 10.3). Among symptomatic patients, results were better in claudicant limbs than in acutely ischemic ones in terms of limb salvage (90.5% and 58.7%, respectively; $P = .001$; log-rank, 17.5). Univariate analysis showed the absence of symptoms, the presence of two or three tibial vessels, the use of a posterior approach, the kind of intervention, and the site of distal anastomosis to significantly affect long-term patency. Cox regression for factors affecting 60-month primary patency showed that clinical presentation, runoff status, and the site of distal anastomosis significantly influenced long-term results.**
Conclusions: **Results of surgery on asymptomatic PAAs are good—significantly better than those for symptomatic ones. Elective surgical intervention should be performed in patients with a low surgical risk and a long life expectancy when the correct indication exists. In thrombosed aneurysms, intra-arterial thrombolysis may represent an alternative to emergent surgical management. Our data demonstrated that results are similarly good in claudicants, and this fact confirms that only acute ischemia due to PAA thrombosis represents a real surgical challenge. In selected patients with focal lesions, a posterior approach seems to offer better long-term results. The runoff status and the site of distal anastomosis affect long-term patency as well. (J Vasc Surg 2006;43:481-7.)**

Popliteal artery aneurysm (PAA) is uncommon, even though the popliteal artery is the second most frequent location of arterial aneurysms.[1] PAA is probably a multifactorial disease: in elderly patients atherosclerosis seems to be the main cause,[2] whereas in younger patients other causes have been hypothesized,[3] such as popliteal artery entrapment syndrome, cystic adventitial degeneration, osteochondroma, and trauma. The main complications of PAA include rupture, distal embolization, and thrombosis[4]; acute leg ischemia due to thrombosis of the PAA is a dangerous complication of this pathologic feature and is often its first clinical manifestation.[5] In these circumstances, the results of urgent surgical intervention are poorer than those of elective intervention in asymptomatic patients and in chronically symptomatic ones.[1,6]

In recent years, with the introduction and large diffusion of catheter-directed intra-arterial thrombolysis, a combined approach of thrombolysis and surgery has been proposed to optimize the results of surgical intervention.[7] The rationale of thrombolytic treatment is to restore the patency of the popliteal and tibial vessels, to convert an

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emergency to an elective situation, and to perform a safer surgical intervention.[5,8]

Moreover, many perioperative factors may influence early and late outcomes in terms of survival, limb salvage, and patency rates.[9] In this article, we evaluate the results of our 20-year experience with surgical management of PAAs, paying particular attention to different results in different clinical presentations. We also reviewed the literature in this field and analyzed any factors potentially affecting early and long-term results.

MATERIALS AND METHODS

From January 1984 to December 2004, 159 PAAs in 137 patients were operated on at our department. Data from all the interventions were retrospectively collected in a dedicated database, which included demographic data, preoperative risk factors, clinical and diagnostic assessment, intraoperative features, and early and long-term outcomes.

Demographic data, clinical status, and diagnostic assessment. Patients were predominantly male (n = 130; 95%; 20 bilateral); 7 patients were female (2 bilateral). The mean age was 68 years (range, 28-91 years; SD, 10 years). Considering common risk factors for atherosclerosis, a history of smoking was present in 70.8% of the patients, 44.5% of the patients had hyperlipemia, diabetes was present in 6.6% of patients, and arterial hypertension was present in 54.7%.

Thirty-two patients (23.4%) had coronary artery disease, and chronic obstructive pulmonary disease was present in 65 patients (47.4%). Other aneurysm localizations were present in 47 patients (34%); 42 patients had aortoiliac aneurysms (previously treated in 30 cases), and 3 had an untreated femoral aneurysm. The remaining two patients had been treated for a renal artery aneurysm and a type IV thoracoabdominal aneurysm.

PAAs were asymptomatic in 67 cases (42%). Among symptomatic PAAs, 51 (32%) caused intermittent claudication. In five cases (3%) the PAA had ruptured; in all these cases, the contained rupture was present, with severe pain and tenderness, subcutaneous ecchymotic lesions, and painful pulsatility in the popliteal space. The remaining 36 limbs (23%) had threatening ischemia, due in 30 cases to acute PAA thrombosis, in 4 cases to chronic PAA thrombosis, and in 2 cases to distal embolization.

All patients underwent Duplex examination and digital subtraction angiography before surgery. Our indication for treating an asymptomatic aneurysm was a diameter greater than 20 mm. In symptomatic patients, the indication for surgery was unrelated to the aneurysm's diameter.

In one third of cases (53 limbs), 3 runoff vessels were patent; in 56 cases, 2 vessels were patent before surgery. The remaining limbs had one or no patent distal vessels. Symptomatic limbs had a significantly lower runoff score than asymptomatic ones (41 cases [44%] with <2 patent vessels in symptomatic limbs; 9 cases [13.4%] with <2 patent vessels in asymptomatic ones; $P = .001$).

Acute ischemia. In selected patients with acutely thrombosed aneurysms, preoperative catheter-directed thrombolysis with urokinase (Urochinasi Crinos; Crinos SPA, Milan, Italy) was performed. Thrombolysis was performed in patients with mild to moderate ischemia (grade I or IIa according to Rutherford's classification), because patients with hyperacute ischemia underwent urgent surgical intervention. Thrombolytic treatment was administered in a bolus of 100,000 IU, followed by continuous infusion with a delivery rate of 50,000/70,000 IU/h. In all patients, 1000 to 1500 IU/h sodium heparin was administered via the same catheter to maintain values of activated partial thromboplastin time two times higher than the normal value and to prevent pericatheter thrombosis and complications due to distal embolization.

Angiographic controls were performed daily or more often, when necessary, and lytic infusion lasted until patency of popliteal and tibial vessels was achieved or for a maximum of 3 days when unsuccessful. The levels of fibrinogen and hemoglobin and the values of international normalized ratio and activated partial thromboplastin time were monitored twice a day during thrombolytic treatment.

Follow-up. The surveillance program consisted of clinical and ultrasonographic examinations at 1, 6, and 12 months and yearly thereafter. Until 1990, the follow-up program consisted of clinical and continuous wave Doppler examination, with measurement of the ankle-brachial index; in this period, the graft was considered to be patent if the ankle-brachial index was unchanged or decreased less than 0.1 with respect to the values at discharge. Since 1990, all patients have undergone duplex scanning examination during follow-up. The patency of the graft and the status of the anastomoses, inflow and outflow vessels, and contralateral femoropopliteal axis were assessed.

Statistical analysis. Early results in terms of mortality, graft thrombosis, and amputation rates were analyzed and compared by χ^2 text or Fisher exact text. Multivariate analyses (stepwise logistic regression analysis) for 30-day mortality, thrombosis, and amputation were performed. Long-term results (survival, primary and secondary patency, and limb salvage) were analyzed by Kaplan-Meier curves, and differences in subgroups were assessed by log-rank test. For multivariate analysis, the Cox regression test was used. Statistical analysis was performed with dedicated software for Windows (SSPS 11; SPSS Inc, Chicago, Ill).

RESULTS

Operative details. Forty cases were treated with aneurysmectomy and prosthetic interposition, whereas in 39 cases the aneurysm was opened and a graft was placed inside the aneurysm in a fashion similar to that used to repair aortic aneurysms. Four patients had aneurysmectomy with end-to-end anastomosis of the popliteal artery. Aneurysmectomy with graft interposition or end-to-end anastomosis was used in patients with large PAAs limited to the popliteal space, easily dissectible from surrounding tissues, or causing compression of veins and nerves or, again, in the presence of saccular aneurysms. In 73 cases, proximal and distal ligation of the aneurysm with bypass grafting (39

Table I. Thirty-day amputation rates

Variable	*30-d amputation rate*	P *value*
Asymptomatic	1/67 (1.4%)	.05
Symptomatic	6/92 (6.5%)	
Claudication	0/51	<.001 for acute ischemia and rupture vs claudication
Acute ischemia	5/30 (16.6%)	
Rupture	1/5 (20%)	
Chronic ischemia	0/6	
Total	9/159 (5.6%)	

with a prosthetic graft and 34 with an autologous vein) was performed. The remaining three patients underwent endovascular exclusion of their PAAs.

A medial approach was used in 97 patients (61%), and a posterior approach was used in 59 patients (37.1%). In endovascular procedures, a percutaneous contralateral femoral approach was preferred. Graft materials consisted of autologous great saphenous vein in 34 cases (21.3%) and a prosthetic graft in 118 cases (74.2%). As already mentioned, four patients had no graft insertion, and three patients had endoprosthesis placement (Hemobahn; W.L. Gore & Associates Inc, Flagstaff, Ariz). In 87 interventions, the inflow vessel was the common or superficial femoral artery, and in the remaining 72, it was the above-knee popliteal artery. The outflow vessel was in most cases the below-knee popliteal artery (93.7%), and in 6.3% of the cases it was represented by a tibioperoneal trunk or a tibial vessel. Intraoperative stop-flow thrombolysis[10,11] was used in 11 patients.

Early (<30 days) results. In our series, mortality was 2.1% (3/137 patients). All the deaths occurred in patients who had a combined surgical intervention (one carotid endarterectomy, one open abdominal aortic aneurysm repair, and one contralateral distal bypass). Two patients were symptomatic (one for rupture and one for critical leg ischemia).

Amputation occurred in 7 (4.4%) of 159 limbs. Of these patients, six were symptomatic: five for acute leg ischemia and one for rupture. The remaining patient was asymptomatic and died in the early postoperative period as a result of acute cardiac failure. There was no bilateral amputation. The amputation rate was significantly higher in symptomatic limbs than in asymptomatic ones (Table I). Among symptomatic limbs, results were significantly better in claudicant patients than in those with acute limb ischemia or rupture.

In eight cases (5%), early graft thrombosis occurred and necessitated a reintervention during the same hospital stay. All the reinterventions were successful, and neither amputations nor deaths occurred in these patients. On univariate analysis, no preoperative risk factor or intraoperative parameter showed an increased risk for 30-day amputation or death.

Preoperative thrombolysis. Seventeen limbs with mild to moderate acute leg ischemia underwent intra-arterial preoperative thrombolysis for acutely thrombosed aneurysms. The median duration of thrombolysis was 13 hours (SD, 34.7 hours); the mean dose of urokinase was 100,000 IU/h per patient (range, 50,000-200,000 IU). In 11 limbs (64.5%), thrombolysis was successful, with complete restoration of patency of the aneurysm and at least of one tibial vessel. Only one minor hemorrhagic complication occurred in the femoral puncture site and did not require a surgical correction.

Long-term results. Follow-up was available in 116 patients (84.7%) and 138 limbs (86%), with a mean follow-up time of 40 months (range, 1-205 months). In this period, 13 deaths (none related to previous interventions), 6 amputations, and 24 graft thromboses occurred. The cumulative estimated 60-month survival, limb salvage, and primary and secondary patency were 84.2%, 86.7%, 66.3%, and 83.6%, respectively.

In the group of 24 occluded grafts, 19 patients underwent treatment for acute limb ischemia; intra-arterial thrombolysis was performed in 8 cases (followed in 2 cases by endovascular or surgical associate procedures), whereas 11 patients underwent redo surgical interventions. Five of the occluded grafts did not require a reintervention because collateral pathways allowed a sufficient distal perfusion without the occurrence of critical limb ischemia. In the entire group, reinterventions were performed in 23 patients: 19 for graft thrombosis, 3 for anastomotic false aneurysms, and 1 for graft dilatation.

Analyzing our results on the basis of clinical presentation, asymptomatic limbs showed significantly better results in terms of limb salvage and primary patency (Table II; Figs 1 and 2). Among symptomatic limbs, those with intermittent claudication had better long-term results in terms of survival and limb salvage than acutely ischemic limbs (Table III; Fig 3).

We investigated all possible preoperative and intraoperative factors affecting primary patency at 60 months. Univariate analysis showed the absence of symptoms, the presence of two or three tibial vessels, the use of a posterior approach, the kind of intervention, and the site of distal anastomosis to significantly affect long-term patency (Table IV). Only clinical presentation, runoff status, and the site of the distal anastomosis maintained significance at multivariate analysis (Table V).

DISCUSSION

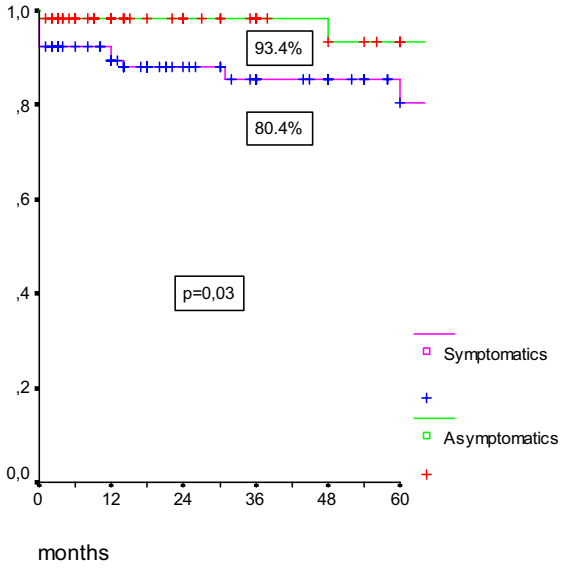
Several studies have analyzed the natural history of PAAs. Gifford et al[12] reported a complication rate of 76% at 5-year follow-up in 21 patients with untreated asymptomatic PAAs. Other studies[13,14] demonstrated that 18% to 100% of patients with asymptomatic PAAs developed acute or chronic limb ischemia; all these patients required a surgical intervention, with an amputation rate of 13%.

If the PAA remains untreated, the risk of complications increases over time. Roggo et al[15] followed up 45 asymptomatic patients for 16 years, and all patients developed acute

Table II. Estimated 60-month results

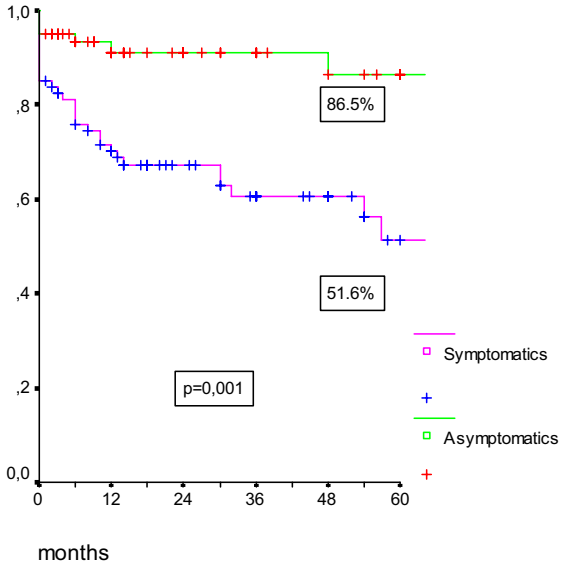
Variable	*Symptomatic (%)*	*Asymptomatic (%)*	*Log-rank*	P *value*
Survival	87	81.4		NS
Limb salvage	80.4	93.4	4.2	.03
Primary patency	51.6	86.5	10.3	.001
Secondary patency	79.6	89.4		NS

NS, Not significant.



Months	0	12	24	36	48	60
Asymptomatics (n. at risk)	61	42	31	24	19	15
Symptomatics (n. at risk)	79	62	39	31	25	16

Fig 1. Sixty-month estimated limb salvage in symptomatic and asymptomatic limbs.



Months	0	12	24	36	48	60
Asymptomatics (n. at risk)	61	41	29	23	19	15
Symptomatics (n. at risk)	79	50	33	24	18	8

Fig 2. Sixty-month estimated primary patency in symptomatic and asymptomatic limbs.

or chronic limb ischemia: 50% within 2 years and 75% within 5 years. Dawson et al[1] observed in a follow-up study on asymptomatic PAAs that 57% of the patients required surgical intervention (83% within 2 years). Lowell et al[14] identified some risk factors for the development of ischemic complications in patients with an asymptomatic PAA larger than 20 mm at Duplex scan examination: a poor runoff status and a large amount of mural thrombus. All these studies demonstrated that the risk of severe complications, such as amputation, is high in patients with asymptomatic aneurysms if they are not promptly treated. As a consequence, considering the good results of reconstructive infrainguinal surgery, it is nowadays difficult to justify a conservative management for this type of disease. Many authors[16,17] recommend elective surgical intervention for asymptomatic aneurysms larger than 20 mm in patients with a low surgical risk. However, several authors[6] suggest surgical reconstruction of any PAA with mural thrombosis, notwithstanding the diameter of the aneurysm sac.

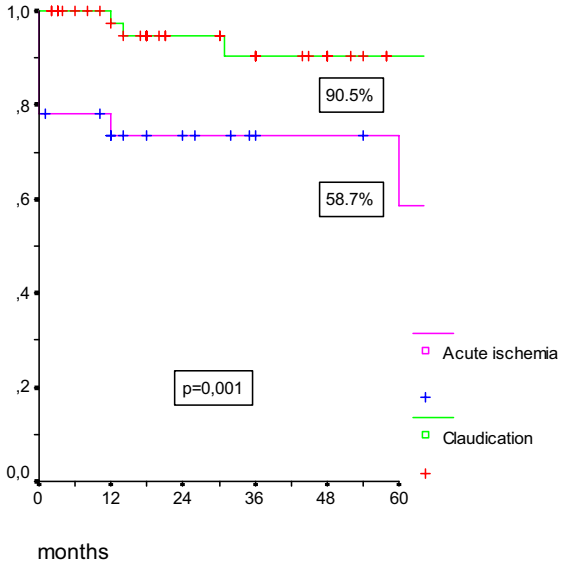
However, only one third of the patients with PAA are asymptomatic at diagnosis[1]; of the remaining two thirds who have symptoms, nearly 10% have PAA rupture, 5% to 10% have signs and symptoms of nerve or venous compression, and the remaining patients have limb ischemia.[6,8] Also in our series, in most cases (58% of the affected limbs) signs and symptoms of chronic or acute limb ischemia were present.

Data from the literature demonstrate that the results of surgical or endovascular treatment are strongly affected by the clinical presentation of PAA.[18,19,20] The 30-day amputation rate remains high when the patient is symptomatic. Reilly et al[21] reported an early amputation rate of 35% in 66 patients with acute aneurysmal thrombosis and an amputation rate of 15% due to early graft thrombosis. Moreover,

Table III. Estimated 60-month results in symptomatic patients

Variable	*Claudication (%)*	*Acute limb ischemia (%)*	*Chronic limb ischemia (%)*	*Rupture (%)*	*Log-rank*	P *value**
Survival	96.6	77.4	75	66.6	10.7	.03
Limb salvage	90.5	58.7	100	75	17.5	.001
Primary patency	50.3	42.1	83.3	75		NS
Secondary patency	83.2	69	100	75		NS

NS, Not significant.
*Between claudication and acute limb ischemia.



Months	0	12	24	36	48	60
Claudication (n. at risk)	46	37	25	21	16	10
Acute ischemia (n. at risk)	22	15	10	6	6	4

Fig 3. Sixty-month estimated limb salvage in symptomatic limbs (claudication vs acute ischemia).

they reported an intraoperative mortality rate of 5.4%. Other authors[22] with large series described amputation rates ranging from 16% to 43% in patients with acute severe limb ischemia due to aneurysmal thrombosis. Also, our results confirm the severity of this clinical situation (16.6% and 20% of amputations in patients with preoperative acute limb ischemia and aneurysm rupture, respectively).

The introduction in clinical practice of intra-arterial thrombolysis has somewhat modified the management of patients with acute limb ischemia due to a thrombosed PAA. Many authors[23,24] have suggested intra-arterial thrombolysis as an effective alternative to emergent surgical intervention.

Our previous experience[5] demonstrated that preoperative intra-arterial thrombolysis in selected patients with acute limb ischemia due to aneurysmal thrombosis allowed partial or complete recanalization of thrombosed PAAs in approximately two third of the cases and showed that, when successful, preoperative thrombolysis provides better results that urgent surgery alone, without compromising the results of surgery if unsuccessful. For this reason, and in the

Table IV. Univariate analysis for primary patency at 60 months

Variable	*%*	*Log-rank*	P *value*
Clinical presentation			
Asymptomatic	86.5		
Symptomatic	51.6	10.3	.001
Sex			
Male	66.3		
Female	75		NS
Smoking			
No	64.1		
Former	70.5		
Yes	59		NS
Hyperlipemia			
No	56.5		
Yes	72.9		NS
Diabetes			
No	65.5		
Yes	80		NS
Hypertension			
No	64.5		
Yes	67.4		NS
Runoff status (vessels)			
0	34.4		
1	63.3		
2	71.9		
3	92.8	24.7	.0001
Surgical approach			
Medial	55.8		
Posterior	82.35	7.1	.007
Intervention			
End-to-end anastomosis	100		
Aneurysmectomy	71.5		
Endoaneurysmectomy	77.6		
Ligation and bypass	54.7		
Endovascular	100	3.9	.04*
Graft material			
Polytetrafluoroethylene	71.5		
Vein	79.9		NS
Proximal anastomosis			
Common femoral artery	66		
Superficial femoral artery	56.1		
Popliteal artery	73.2		NS
Distal anastomosis			
Popliteal artery	68.6		
Tibial vessels	34.6	3.7	.05

NS, Not significant.
*Between endoaneurysmectomy and ligation and bypass.

Table V. Cox regression of factors affecting 60-month primary patency

Variable	*Odds ratio*	*95% CI*	P *value*
Symptomatic	4.9	1.3-17.8	.01
Poor runoff status	10.6	1.9-91.2	.03
Posterior surgical approach	3.8	0.8-18.1	.08
Type of intervention	0.8	0.4-1.8	.7
Graft material	0.6	0.2-2.0	.4
Site of proximal anastomosis	2.2	0.8-5.7	.09
Distal anastomosis on tibial vessels	8.6	1.6-45.1	.01

CI, Confidence interval.

absence of major complications during thrombolysis in our patients, we adopted a policy of routine intra-arterial thrombolysis in patients with mild to moderate acute limb ischemia due to thrombosis of PAAs.

Good early and late results have been reported with elective intervention. In a series of 80 asymptomatic and symptomatic patients who underwent elective surgical intervention, Varga et al[6] reported a primary patency of 99%, with neither deaths nor amputations at the early follow-up. Similar results were reported in other series,[9,13-14] pointing out the benefits of surgery in asymptomatic patients with respect to symptomatic ones.

The patency on long-term follow-up seems to be related to the presence of preoperative symptoms as well. The primary patency rates at 5 years in asymptomatic patients ranged from 82% to 97% but decreased to 39% to 70% in symptomatic ones.[25] In our series, only one asymptomatic patient had an early amputation, and in the asymptomatic group, the primary patency at 5 years was 86.2%. Moreover, our data demonstrated that among symptomatic patients, results are significantly better in the presence of intermittent claudication or chronic ischemia than with acute limb ischemia or aneurysmal rupture; this result suggests the need for treating symptomatic patients before major complications occur.

An interesting result is that concerning early mortality: all deaths occurred in patients who had two combined surgical procedures. This fact can represent a caveat in choosing to concomitantly treat patients with multilevel disease.

Other factors described to affect primary patency were the presence of at least two tibial vessels, the surgical approach, the graft material, and the site of distal anastomosis. Runoff status significantly influences long-term limb salvage and primary patency rates.[9,26,27,28] In our series, primary patency at 5 years was 72% in patients with the presence of at least two tibial vessels, whereas this rate decreased to 47.4% in patients with a worse runoff status.

Concerning the surgical approach, Mahmood et al[29] demonstrated that it was not a predictor of graft failure with either univariate or multivariate analysis in 52 patients who underwent operation. Martelli et al[30] suggested that the surgical approach depended on the size and the extent of the aneurysm; however, they did not find any differences between the medial and posterior approach for primary patency and limb salvage during follow-up. Conversely, Ouriel[31] reported good results with the posterior approach in occlusive disease that required bypass graft anastomosis to the proximal third crural vessels. Also in our experience, at univariate analysis, the posterior approach significantly improved primary patency at 5 years. This result was not confirmed at multivariate analysis, thus suggesting that it can represent a safe and effective approach only in selected patients with more focal lesions or with good runoff status.

According to many authors, the graft material seems to influence early and late results.[6,25] However, in our experience, graft material did not influence primary patency at 5 years; for this reason, we use polytetrafluoroethylene as a safe alternative when autologous vein is not available or when the revascularization is limited to the popliteal artery.

The site of distal anastomosis seems to affect early and late outcomes, too. Aulivola et al[26] reported the results of 39 patients with 51 PAAs; the outflow vessels were infrapopliteal vessels in 57% of the cases, and this site of distal anastomosis played a crucial role in the treatment of PAA, especially in patients with critical limb ischemia. Indeed, in our series, the use of an infrapopliteal vessel as the site of distal anastomosis did affect primary patency at 5 years in both univariate and multivariate analysis.

CONCLUSIONS

From our study and others, it seems clear that the results of operation on asymptomatic PAAs are good and are significantly better than those with operation on symptomatic PAAs. Elective surgical intervention should be performed in patients with a low surgical risk and with a long life expectancy in the presence of PAAs with a diameter larger than 2 cm or with a large amount of mural thrombus found at duplex scan. In thrombosed aneurysms, intra-arterial thrombolysis may be an alternative to emergent surgical management.

Our data demonstrated that results are similarly good in claudicants, and this fact confirms that only acute ischemia due to PAA thrombosis represents a real surgical challenge. In our opinion, a policy of elective intervention in asymptomatic patients with accepted indications for surgical repair remains the only way to avoid the development of acute limb ischemia. In selected patients with focal lesions, the posterior approach seems to offer better long-term results. The runoff status and the site of distal anastomosis affect long-term patency as well.

AUTHOR CONTRIBUTIONS

Conception and design: RP, WD
Analysis and interpretation: RP, WD
Data collection: NT, GP, LA, AA
Writing the article: WD, RP, NT
Critical revision of the article: CP, AA
Final approval of the article: RP, CP
Statistical analysis: WD, RP, GP, NT
Overall responsibility: RP, CP

REFERENCES

1. Dawson I, Sie RB, Van Bockel JH. Atherosclerotic popliteal aneurysm. Br J Surg 1997;84:293-9.
2. Evans WE, Conley JE, Bernhard VM. Popliteal aneurysms. Surgery 1971;70:762-7.
3. Lambert AW, Wilkins DC. Popliteal artery entrapment syndrome. Br J Surg 1999;86:1365-70.
4. Szilagy DE, Schwartz RL, Reddy DJ. Popliteal arterial aneurysms: their natural history and management. Arch Surg 1981;116:724-8.
5. Dorigo W, Pulli R, Turini F, Pratesi G, Credi G, Innocenti AA, et al. Acute leg ischaemia from thrombosed popliteal artery aneurysms: role of preoperative thrombolysis. Eur J Vasc Endovasc Surg 2002;23: 251-4.
6. Varga ZA, Locke-Edmunds JC, Baird RN. A multicenter study of popliteal aneurysms. Joint Vascular Research Group. J Vasc Surg 1994; 20:171-7.
7. Marty B, Wicky S, Ris HB, Mueller X, Fischer A, Hayoz D, et al. Success of thrombolysis as a predictor of outcome in acute thrombosis of popliteal aneurysms. J Vasc Surg 2002;35:487-93.
8. Carpenter JP, Barker CF, Roberts B, Berkowitz HD, Lusk EJ, Perloff LJ. Popliteal artery aneurysms: current management and outcome. J Vasc Surg 1994;19:65-72.
9. Anton GE, Hertzer NR, Beven EG, O'Hara PJ, Krajewski LP. Surgical management of popliteal aneurysms: trends in presentation, treatment and results from 1952 to 1984. J Vasc Surg 1986;3:125-34.
10. Comerota AJ, Schmieder FA. Intraoperative lytic therapy: agents and methods of administration. Semin Vasc Surg 2001;14:132-42.
11. Pulli R, Dorigo W, Azas L, Di Carlo F, Fargion A, Pratesi G, et al. Trombectomia chirurgica sotto controllo fluoroscopico e trombolisi intraoperatoria nell'ischemia acuta periferica. In: Pratesi C, Pulli R, editors. Le emergenze vascolari. Aspetti gestionali e problematiche terapeutiche. Torino: Edizioni Minerva Medica; 2004. p. 158-63.
12. Gifford RW, Hines EA, Janes JM. An analysis and follow-up study of one hundred popliteal aneurysms. Surgery 1953;33:284-93.
13. Whitehouse WM Jr, Wakefield TW, Graham LM, Kazmers A, Zelenock GB, Cronenwett JL, et al. Limb-threatening potential of arteriosclerotic popliteal aneurysms. Surgery 1983;93:694-9.
14. Lowell RC, Gloviczki P, Hallett JW Jr, Naessens JM, Maus TP, Cherry KJ Jr, et al. Popliteal artery aneurysms: the risk of nonoperative management. Ann Vasc Surg 1994;8:14-23.
15. Roggo A, Brunner U, Ottinger LW, Largiader F. The continuing challenge of aneurysms of the popliteal artery. Surg Gynecol Obstet 1993;177:565-72.
16. Duffy ST, Colgan MP, Sultan S, Moore DJ, Shanik GD. Popliteal aneurysms: a 10-year experience. Eur J Vasc Endovasc Surg 1998;16: 218-22.
17. Davidovic LB, Lotina SI, Kostic DM, Cinara IS, Cvetkovic SD, Markovic DM, et al. Popliteal artery aneurysms. World J Surg 1998;22: 812-7.
18. Wychulis AR, Spittel JA, Wallace RB. Popliteal aneurysms. Surgery 1970;68:942-52.
19. Vermilion BD, Kimmins SA, Pace WG, Evans WE. A review of one hundred forty-seven popliteal aneurysms with long-term follow-up. Surgery 1981;90:1009-14.
20. Shortell CK, De Wesse JA, Ouriel CK, Green RM. Popliteal artery aneurysms: a 25-year surgical experience. J Vasc Surg 1991;14:771-6; discussion 776-9.
21. Reilly MK, Abbott WM, Darling MC. Aggressive surgical management of popliteal aneurysms. Am J Surg 1983;145:498-502.
22. Halliday AW, Taylor PR, Wolfe JH, Mansfield AO. The management of popliteal aneurysm: the importance of early surgical repair. Ann R Coll Surg Engl 1991;73:253-7.
23. Taurino M, Calisti A, Grossi R, Maggiore C, Speziale F, Fiorani P. Outcome of early treatment of popliteal artery aneurysms. Int Angiol 1998;17:28-33.
24. Steinmetz E, Bouchot O, Faroy F, Charmasson L, Terriat B, Becker F, et al. Preoperative intra-arterial thrombolysis before surgical revascularization for popliteal artery aneurysm with acute ischemia. Ann Vasc Surg 2000;14:360-4.
25. Sarcina A, Bellosta R, Luzzani L, Agrifoglio G. Surgical treatment of popliteal artery aneurysm. A 20 year experience. J Cardiovasc Surg 1997;38:347-54.
26. Aulivola B, Hamdan AD, Hile CN, Sheahan MG, Skillman JJ, Campbell DR, et al. Popliteal artery aneurysms: a comparison of outcomes in elective versus emergent repair. J Vasc Surg 2004;39:1171-7.
27. Gawenda M, Sorgatz S, Muller U, Walter M, Erasmi H. The thrombosed popliteal aneurysm with distal artery occlusion—successful therapy by interdisciplinary management. Thorac Cardiovasc Surg 1995;43: 112-6.
28. Borowicz MR, Robison JG, Elliott BM, Brothers TE, Robinson CK. Occlusive disease associated with popliteal aneurysms: impact on long term graft patency. J Cardiovasc Surg 1998;39:137-40.
29. Mahmood A, Salaman R, Sintler M, Smith SR, Simms MH, Vohra RK. Surgery of popliteal artery aneurysms: a 12-year experience. J Vasc Surg 2003;37:586-93.
30. Martelli E, Ippoliti A, Ventoruzzo G, De Vivo G, Ascoli Marchetti A, Pistolese GR. Popliteal artery aneurysms. Factors associated with thromboembolism and graft failure. Int Angiol 2004;23:54-65.
31. Ouriel K. The posterior approach to popliteal-crural bypass. J Vasc Surg 1994;19:74-9; discussion 79-80.

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